SIR WILLIAM MACLEAY MEMORIAL LECTURE, 1968
WILDLIFE CONSERVATION

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I. Introduction

The distinguished career of Sir William Macleay in Australia, from 1839 to 1891, covered the period when the inland was being occupied by settlers and domestic stock. He was in the forefront of this occupation when, soon after his arrival, he took up country on the Murrumbidgee River west of the present town of Darlington Point.

This country is now in the heart of the Riverina, the district that became the cradle of the wool industry, the location of many of the famous studs, the birth-place of many of the bush ballads and the folk-lore of shearers and jumbuks, shanties and riverboats. Yet, when William Macleay went there, only eleven years after Sturt had probed his way down the river, this was all in the future. We are told that as late as 1842 "very little was known of the country situated on the western side of the main road passing from New South Wales to Victoria on the lower Murray, Edward, Billabong, Murrumbidgee, Lachlan and Darling Rivers. The general impression was that all this lower country to the westward was too dry, too flat and too arid for any purpose, and the few who travelled over it described it as a miserable, wretched, useless country" (Fletcher, 1893).

The actual site of William Macleay's squatterage is not certain. There were many runs on the Murrumbidgee and the Macleays held several and, no doubt, some were registered in the names of financial backers rather than the man actually on the spot. However, by the end of the nineteeth century between Hay and Darlington Point the various squatterages, runs and blocks had consolidated into four stations, "Eli Elwah", "Burrabogie", "Toganmain" and "Kerarbury". The Macleays had had interests in all except the first, and Sir William had held "Kerarbury", part of which had formerly been known as "Uratta", since the fifties. "Kerarbury" has since been subdivided and, although a Kerarbury Station still exists, the block where the original homestead is thought to have been is immediately to the west and is known as "The Homestead".

To a naturalist, however, of greater concern is not that the old homestead has disappeared and its location is not certain, but that most of the wildlife of the region has also disappeared and its original composition even is not certain.

II. Small Mammals

In many years' research on the Murrumbidgee plains, apart from rabbits, domestic stock and feral foxes and cats, the only mammals seen have been red and grey kangaroos, *Megaleia rufa* and *Macropus giganteus*, an occasional marsupial mouse, *Sminthopsis crassicaudata*, and a few brush-tailed possums, *Trichosurus vulpecula*, wherever there is some timber. There are probably also

a few water rats, *Hydromis chrysogaster*, somewhere on the river, but I have not seen them.

In 1958 Marlow published maps of marsupial distribution based on his own observations and on museum records. The startling fact of these maps is that apart from the red kangaroo, grey kangaroo, brush-tailed possum and fat-tailed marsupial mouse, all of which are common today, there are virtually no historical records of marsupials in western New South Wales. The records of native rodents are likewise poor. Either inland New South Wales was without small mammals at the beginning of settlement, or there has been a disastrous decline in most species. The latter is, of course, probably the case.

It is one of the tragedies of the early settlement of this country that the mammal fauna of the inland was allowed to perish without even having been described. There seems to have been no organized collecting or recording done in the Riverina, and many animals that could have been common have disappeared from the State and in some cases from the whole continent.

We will never know with certainty the original composition of the fauna of the inland plains, and can only try to build up a picture from the few records from the surrounding areas and from what little we know of the biology of some of the animals that have survived elsewhere in the continent.

Most of the information on inland marsupials comes from the results of an expedition led by William Blandowski in 1856–1857 and from the work of John Gould in 1839–1840. The former expedition was financed by the Victorian Government and led by William Blandowski, but Gerard Krefft was the report writer and published papers on the expedition. Wakefield (1966) has examined the literary accounts and the surviving records. The expedition was in the field for a year, and, having reached the Murray River near Echuca, followed it to about the present site of Mildura, where they camped for several months. Excursions were made in several directions, including one of about 300 miles to the north-east. They found a very rich fauna and collected several hundred mammals representing over 30 species. Judging from the numbers collected of some species, they must have been very common. John Gould collected on the Upper Hunter River and on the Liverpool Plains to the west of the Divide and north-westward from there.

Although both these areas are some distance from the Murrumbidgee, it is a fair assumption that species collected both at Liverpool Plains and the junction of the Murray and Darling Rivers would probably also have occurred along the Murrumbidgee. Among these are the barred bandicoot, *Perameles fasciata*, that has not been recorded in New South Wales since Krefft's 1857 expedition and is not known to occur anywhere today, and *Bettongia penicillata*, that has not been recorded in New South Wales for 50 years and is now only known with certainty in south-western Australia; the bettong was also recorded near Gundagai in 1832. The rufous rat-kangaroo, *Aepyprymnus rufescens*, was common on the Murray, but is now found nowhere inland; the brown hare wallaby, *Lagorchestes leporides*, was also recorded near Booligal in 1890, but this was the last record for New South Wales, and it is not known to occur anywhere today; the bridled nail-tail wallaby, *Onychogalea frenata*, has not been seen anywhere for 30 years; the mouse, *Thetomys gouldii*, also seems to have gone as there has been no information for a long time.

Some species recorded by Krefft, but not by Gould, probably did not reach as far east as "Kerarbury", but some certainly did. The rabbit-eared bandicoot, *Macrotis lagotis*, had a wide distribution in New South Wales, but the last record was near Wagga in 1912. The pig-footed bandicoot, *Chaeropus ecaudatus*, was known in south-western New South Wales until 1880, but is

now probably extinct. Lesueur's rat-kangaroo, *Bettongia lesueuri*, was abundant in much of inland New South Wales, but is now known for certain only on islands off the coast of south-west Australia.

Kershaw (1909) recorded the hairy-nosed wombat between Deniliquin and Billabong Creek, not far south of "Kerarbury", in 1884, and these were apparently the only examples ever collected in New South Wales. It was long believed that they were the same as the South Australian species *Lasiorhinus latifrons*, but Crowcroft (1967) has shown them to be of the southern Queensland species *L. gillespiei* which is also extinct. It may have also occurred on the Murrumbidgee.

The native rodent, *Leporillus apicalis*, which is now probably extinct, probably extended to the Murrumbidgee, and perhaps also *Notomys mitchelli*. There may have been other native rodents in the area, particularly in the *Pseudomys* group of genera, as Krefft recorded several at the Murray – Darling junction and Gould and others collected some of these and other species on the Liverpool Plains.

Marlow points out that of the 52 species of marsupials that have been recorded in New South Wales, 42% are presumed extinct or rare. Calaby (1963) considers that of the 119 marsupials in Australia, five are extinct and 34 are endangered. The position with the native rodents is similar but less well documented, largely because of taxonomic difficulties. Needless to say, virtually nothing is known of the biology of any of these animals, and surviving collections in museums are hopelessly inadequate.

One of the significant things about this disaster is that most of the animals that have disappeared or are endangered have never been persecuted, or very little. Their disappearance, often unnoticed, is an incidental and insidious byproduct of alteration of the habitat by stock.

III. Kangaroos

While the small marsupials of the inland declined before settlement, the red kangaroo, *Megaleia rufa*, for a time prospered. Krefft recorded in 1857: "The Red Kangaroo (*Osphranter rufa*) is to all appearance very scare as not a single specimen was brought in during our stay at Gunbower by the natives." Many of the explorers' journals in New South Wales and elsewhere in the inland also give the impression that red kangaroos were not numerous, yet towards the end of the 19th century organized drives in the Riverina and elsewhere were accounting for many thousands in quite small areas. By 1957 it was widely held that they were in "plague proportions" in the inland, in places outnumbered the sheep, and were a major pest. There was accordingly a great deal of research on this and other kangaroos, and it has been possible to judge these claims and to learn a lot about the biology of the animals. Should a determined effort be made to conserve them, the essential biological data on which to base these efforts are now available.

Much of the Murrumbidgee flood plain is now grassland, with scattered clumps of boree, pine and black box. The most extensive grasslands are of *Danthonia* and *Stipa/Danthonia*. There is general agreement among plant ecologists (Beadle, 1948; Moore, 1953*a*, *b*; Williams, 1955) that these are disclimax communities produced by grazing. Originally the area was mainly a low shrub woodland of boree and other small trees.

Aerial counts of the density of kangaroo populations between Hay and Darlington Point have shown that in the period 1960–1963 the wallaby grass plains supported on the average 4·1 kangaroos to the square mile, but of the woodlands pine-belah supported only 0·1 and the belah-rosewood 1·5 kangaroos

to the square mile. Of the total animals counted, 79% were on the wallaby grass plains (Frith, 1964; Frith and Calaby, 1969). These results, combined with the common observation that red kangaroos are usually most numerous on short green grass and least numerous on long dry herbage, leave little doubt that the abundance of kangaroos in the area is related to grazing on the virgin habitats.

Newsome (1965) has reported similar results from central Australia with land grazed by cattle, and there is further evidence from the north-west corner of New South Wales that the abundance of red kangaroos can be attributed to sheep grazing also (Bailey, 1967). Ealey (1968) in north-west Australia has concluded that the abundance of euros, *Macropus robustus*, also is a direct result of the impact of sheep on a delicately balanced natural vegetation; the sheep overgrazed it to the point of their own destruction, but created ideal euro habitat.

This kind of situation, of course, means that kangaroos pose quite different conservation problems than do many animals. They are abundant in a particular stage of botanical succession and, if the composition of the pasture changes due to increases or decreases in the stocking rate with domestic stock, the size of the kangaroo populations will fluctuate also. In the meantime, because of their abundance, they are held to be serious competitors with stock by many, and several States have allowed uncontrolled slaughter both by pastoralists and by those who shoot the animals for their meat and hides. The main features of the biology of the red kangaroo are now known, and it is possible to be rather more definite about the factors that control kangaroo populations than it was a few years ago when the controversy about kangaroos in inland New South Wales was at its height.

They are not nearly so wide-ranging as has been thought. In mild weather no marked animal has been found more than 30 miles from the place of marking, although in drought some have moved up to 130 miles. The amount of food eaten is not several times that of a sheep as has been often claimed; in bulk it is similar. It is not possible, however, to equate sheep with kangaroos as forage removers unless their food preferences are the same. A current study shows that, although there is a broad similarity in the plants eaten, there are significant differences. Many plants, relished by sheep, are avoided by kangaroos and vice versa. The two animals have specific food preferences and so are not in complete competition. There are similar results from central Australia with red kangaroos and cattle (Newsome, 1967).

Mortality in the pouch varies with the climatic conditions. In a favourable environment loss of pouch young is about 15%, but in mild drought the number failing to leave the pouch increases (Frith and Sharman, 1964). A further adaptation to drought is that many females fail to have a post-partum oestrus and cease breeding until rain falls.

In the recent drought breeding of red kangaroos ceased, most of the pouch young and young at foot perished, and the adults dispersed, fell in condition and many perished. Yet all the time uncontrolled shooting continued. It is no wonder the populations declined and kangaroos became uncommon over very large areas. On the Murrumbidgee between 1960 and 1963 the average density fell from 8·6 to the square mile to 2·7, and on the Darling River it fell from 6·3 to 2·2 and in both places there were later obvious declines that were not measured (Frith, 1964). In the north-west corner of the State the density fell from 6·3 to the square mile to 1·2 between 1964 and 1966, and in central Australia between 1959 and 1966 it fell from about 10·0 to 1·9 animals to the square mile (Newsome, 1966).

Faced with this dramatic decline, New South Wales and Northern Territory strengthened their administrative machinery to control it, but neither New South Wales nor any other State at present has the manpower to institute and conduct an effective management programme. Until this is done kangaroo conservation must remain a matter of chance.

There is no doubt that red kangaroos can be preserved, as a species, in reserves. However, the animal is a valuable resource and it seems appropriate that they should also be conserved on land devoted to pastoral industries. Since the original settlement the stock numbers in inland New South Wales have followed the common pattern for arid areas. The numbers of sheep initially are high, but very quickly decline. In the Western Division, for example, at the end of last century, there were thirteen million sheep, but due to degradation of the rangeland the area now can only carry seven million. However, the biomass of animals is probably still much the same, the missing six million sheep being in the form of kangaroos which are in themselves a valuable resource. Kangaroo management depends on the Australian community and Governments realising that domestic stock are not the only means of utilizing much of the arid zone. A long-term husbandry based on both stock and kangaroos will probably be less productive than one based on stock alone, but certainly more permanent.

IV. Waterfowl

The Murrumbidgee plains have been an appropriate place to study another complex problem of wildlife conservation, that of several species of waterfowl. Although the problems of kangaroo conservation are difficult, they are not insoluble. The position of waterfowl, however, is more complicated as they demand the management of water conservation schemes with the needs of waterfowl in mind just as much as other products of more economic value.

Australian waterfowl were apparently never very numerous, and in the erratic, semi-arid environment one might assume that the populations would be quite delicately balanced and not need a great deal of interference with their habitat to upset them. This interference has been applied at several critical points in the life history of many species and they now are declining rapidly. The reasons are quite well known, but those responsible for wildlife conservation have been able to do little to halt the decline.

The inland waterfowl need a breeding place, a nearby refuge for dry weather and a permanent refuge for extended dry periods and droughts. These can be separated by great distances, but, unless they are available at the appropriate time, the populations cannot survive. At present, all these types of habitat are vulnerable to settlement and are being steadily destroyed.

The inland rivers wind across their flood plains and local rainfall has little effect on their level; the level is controlled by rain or melting snow on the highlands, hundreds of miles to the east. In years of adequate rain the rivers rise, often in spring, but at whatever season the rain falls the billabongs, lagoons and effluent streams fill. In times of heavy rain there are great floods that cover thousands of square miles with water a few inches deep. In extreme years the waters of the Murrumbidgee and the Murray, over one hundred miles to the south, join across the plains. In dry years the billabongs do not fill or rise in level only slightly. In very dry years the rivers cease to flow or become dry and so do the billabongs.

In the northern hemisphere, where much of the pioneer work on the factors controlling the breeding seasons of birds was done, birds tend to have fairly

regular breeding seasons and nest at a fixed time each year. It has been concluded that, in general, the sexual cycle is controlled by the increase in day length that occurs at a fixed time each spring and that the actual breeding season is timed, within these quite narrow limits, by more immediate environmental factors such as the availability of nest sites, etc. (Lack, 1954; Rowan, 1926). Such a mechanism in semi-arid Australia would, more often than not, result in the ducklings being hatched at a time when the rivers were low and the billabongs dry with a resultant disaster to the young of that year.

It has now been shown that Australian waterfowl can breed at any time of the year that suitable conditions exist for the survival of the young. In unfavourable years they do not breed at all. The breeding season is directly geared to changes in waterlevel in the billabongs. Even though the plains may be gripped by drought, should rain on the catchments cause a local increase of a suitable speed and extent in the waterlevel of the billabong, the birds breed (Frith, 1959*c*). In this way it is ensured that the waterfowl do not breed when the habitat is unfavourable and also that favourable circumstances are not missed, no matter at what time of the year they occur.

All the common waterfowl of the billabongs receive a sexual stimulus from the rising waterlevel, but the speed of the reaction varies from species to species. The grey teal, *Anas gibberifrons*, is the most rapid, and ovulation can follow within a few days of the first sign of the rising water. The pink-eared duck, *Malacorhynchus membranaceus*, also receives an immediate stimulus, but the eggs are not laid until it is certain that the rise in waterlevel is going to be maintained and actual flooding of the plains will follow. This difference is related to the food requirements of the two birds; the grey teal can use a very wide variety of food from many sources and this is made available by the rising water. The most important insects also have breeding seasons geared to the rising waterlevel and the shallows become dense with their young by the time the ducklings hatch. The pink-eared duck is a food specialist and lives on microscopic plants and animals that are only abundant in shallow drying floodwater. Other ducks have different speeds of response; the black duck, *A. superciliosa*, breeds as the waterlevel approaches its maximum, the hardhead, *Aythya australis*, breeds immediately after the maximum level, and the freckled duck, *Stictonetta naevosa*, a little after that (Frith, 1959*c*, 1965). There are two species, the blue-billed duck, *Oxyura australis*, and the musk duck, *Biziura lobata*, that are restricted to the few deep semi-permanent cumbungi swamps in the region and, being in a "safe" habitat, have no need for an erratic breeding season. They breed at a regular time each year and there is reason to believe that these have retained a photoperiodic effect in the timing of their breeding seasons (Braithwaite and Frith, 1969).

How the rising waterlevel stimulates the sexual cycle of species with erratic breeding seasons has been the cause of some speculation — did the waterlevel act as a visual stimulus or did it operate through some other intermediate factor. Recent work with nine species, ranging from those with the most regular breeding seasons to those with the most erratic, has suggested that in some species the waterlevel change affects the abundance of food which in turn affects the nutrition of the birds and this permits breeding. In those species having erratic breeding seasons the normal germinal cell division for spermatogenesis and the necrosis of these cells are not separated; they occur concurrently, so that at any time the testis is primed, as it were, for an immediate response to suitable nutrition of the bird. Both processes are reversible, so that, should a bird receive a stimulus that is not maintained, it

can rapidly reverse the spermatogenic cycle. Some species can continue sperm production throughout the year, even during moult (Braithwaite, 1969; Braithwaite and Frith, 1969).

Floods and even full billabongs are not permanent features of the inland plains, and as the water areas decrease the birds must disperse. It has been shown that these movements are multidirectional (Frith, 1959*d*). The movement is an explosive random dispersal with birds moving in all directions. The degree of mobility varies from species to species and the distance travelled depends on the abundance of habitat. The birds apparently fly in straight lines until a suitable swamp is found and there they remain until it in turn becomes unsuitable. There is then another random dispersal. A bird having left the Murrumbidgee only returns by chance. Those that do not find a suitable swamp on the outward movement carry on, and many presumably fly out to sea and perish (Frith, 1962, 1963).

Very few of the drought refuges are in the inland as little permanent water exists there. The few cumbungi swamps that do exist are crowded each summer with great numbers of many species of waterfowl. It has been possible to show that, although as many as nine species can crowd together on the one swamp for long periods, they are effectively isolated ecologically by having different bill structures, enabling different feeding methods, different feeding places; e.g., some dive to the bottom of deep water and others feed only on the surface and have different abilities to use different food items (Frith, Braithwaite, and McKean 1969). They seldom compete for food. The cumbungi swamps are capable of supporting the birds for long periods, but eventually they must move again to the ultimate drought refuges, the coastal lagoons of the eastern, south-eastern and northern coasts, where they remain until the inland rivers flood once more.

The causes of the decline in waterfowl populations are now apparent. The needs of water conservation and hydro-electric power have led to continuing efforts to control the flow of the inland rivers and to prevent their flooding. Each water conservation structure built in the highlands and each weir built on the plains to divert water for irrigation decrease the frequency with which the water level in the billabongs increases in level and thus decrease the frequency of breeding of the waterfowl. Even those birds that do breed are finding it increasingly difficult to find a suitable drought refuge. The trend of agriculture on the coast is to drain every swamp and pool whether this will produce productive land or not. Perhaps the productivity of many farms would be increased more by pasture improvement on existing pastures than by draining a few acres to produce another boggy tussocky pasture.

If waterfowl are to survive in south-eastern Australia, it must be recognized that they need living space, and very positive efforts need to be made to ensure their conservation.

V. Wildlife Conservation

Australia's record towards its wildlife has been generally poor. Those animals that do not provide products whose value can be measured in money, or that are not useful as game, have been ignored so that their survival in the face of increasing pastoral and agricultural use of the land has been purely a matter of chance. Those that were hardy enough or adaptable enough to withstand the changes to the environment have survived; those that were not have declined seriously or have disappeared. Most of those that do provide economic products have been exploited to the point where they are incapable of providing anything.

I can find no example of successful management of an animal that has been used to provide economic products. In each case the treatment has followed the same pattern. The exploitation of the animal is uncontrolled until the populations have been reduced to a low level. Attempts to control the industry are then applied, but are often based on legislation rather than on biology or are not effectively policed or both. The animals continue to decline in numbers to the point where the industry is no longer profitable, having destroyed its own resources. By this time public opinion is so outraged that the animal is afforded complete and virtually unalterable protection.

Apart from the few mammals and birds that have been the subject of special studies, conservation is hindered because the wildlife generally is not well known, so that it is difficult to set targets, and little is known of the biology of even common species so that reserves can be sensibly managed.

The need for active management of the wildlife in reserves is shown by many examples in other countries, but in Australia little has been documented. There are many cases of reserves failing to serve their main purpose in the long term because of inadequate knowledge of the animals and lack of management. I have already mentioned how red kangaroos depend on short green pastures that is not a permanent feature of the ungrazed inland plains. It might be inferred that large populations of the animals can only be retained in reserves if the ground cover is kept in a suitable state by grazing some domestic stock. On the other hand, the mallee fowl was long thought to be endangered by the depredations of foxes, but a study of the bird showed that this was not so; the real reason for the decline was competition with the birds for food by stock and rabbits; mallee fowl cannot be conserved unless grazing stock are excluded and rabbits eradicated from the reserve. The re-discovered Leadbeater's possum needs an early stage of the regeneration of *Eucalyptus regnans* with trees 25 to 30 years old so that a dense tangle of *Acacia* grows below (Warneke, pers. comm.). Its retention in numbers would depend on rotational clearing of parts of the reserve.

Colonies of koalas appear on the closely settled coast and often are too closely protected from interference by the local communities. The problem with many of these is that they are in small isolated areas of habitat where regeneration of the trees is prevented by dairy cows and, due to the very close protection, the koalas increase in numbers to the point where they overgraze and destroy the mature trees with disaster to the whole colony.

The recently re-discovered New Holland mouse, *Pseudomys novaehollandiae,* promises to show the full cycle of man's unconscious management of an area. Only one had been seen in 130 years when it was found to be abundant near Port Stephens, N.S.W. The reason for its abundance is considered to be a disclimax community of *Acacia* and bracken caused by frequent accidental burning of the forest, but the next phase of the development is to destroy the area during mining for rutile and other minerals. But for the chance encounter by an experienced observer the animal might have disappeared unnoticed for another 130 years (Keith and Calaby, 1968).

Even if the naturalists of the early days had recognized the extreme vulnerability of the small ground-living mammals, it is difficult to imagine how they might have prevented the decline then when we still fail today. Even had reserves been created on the plains and fenced against stock in an age when it was not normal to fence even pastoral holdings, this could hardly have been done before the rabbit invasion which would have destroyed the habitat anyway. In that age, before it was realized that a knowledge of an

animal's ecology is essential for its conservation and the management of reserves, before it was even realized that the science of ecology existed, the management of any reserves secured on the plains would have been a very chancy affair. Perhaps the best contribution the early naturalists could have made would have been to ensure that there was documentation of the animals' distribution, adequate collections in the museums, and the establishment of captive colonies against the day when the Governments would be able to secure and staff adequate reserves.

Today there is improved legislation and a wider interest in conservation. There are many reserves of varying value and, although few have been chosen for their wildlife values, this is being rectified in places. Nevertheless, there are very few reserves where the wildlife is adequately studied and properly managed so that it will remain abundant. There is no educational establishment that provides training in the techniques of wildlife management.

VI. Conclusion

In this talk I have tried to show that wildlife conservation is a complex process. A great deal of the wildlife has disappeared and many species are still declining, even though the essential facts to halt their decline are now known.

The mammal fauna of inland New South Wales disappeared very early in the history of settlement due to changes in the environment induced by settlement. It is important to realize that these and similar changes are still going on, not only in the closely settled areas but the remote ones and in the reserves, and that, unless care is taken, other wildlife species will fail.

If wildlife conservation in Australia is to be a fact and not merely a pious hope, a greatly increased effort in research and management is needed.

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